Instruction Manual

JOHN FLUKE MFG. CO., INC.

ELECTRONICS FOR INDUSTRY

Preliminary Instruction Manual
for
FLUKE MODEL 845A
HIGH IMPEDANCE VOLTMETER/NULL DETECTOR

INSTRUMENTS / COMPONENTS

Serial No. 123 and above

JOHN FLUKE MFG. CO., INC.

P. O. Box 7428, Seattle, Washington 98133

Preliminary Instruction Manual

for

FLUKE MODEL 845A

HIGH IMPEDANCE VOLTMETER/NULL DETECTOR

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SECTION I

SPECIFICATIONS

RANGE: 1 uv through 1000 VDC end scale in nineteen ranges, using X1 and X3 progression.

INPUT RESISTANCE: 100 megohms on 300 mv range and above; 10 megohms on 100 mv range and below.

ACCURACY: ±(2% end scale +0.10 uv)

MAXIMUM NOISE (Input Shorted):

Range	Noise (peak-peak)
1 uv	0.20 uv
3 uv	0.25 uv
10 uv - 1000V	0.30 uv

METER RESPONSE TIME: (to 90% of reading)

Range	Time
1 uv	5 sec.
3 uv	3 sec.
10 uv - 1000V	1-1/2 sec.

INPUT ISOLATION: Better than 10^{12} ohms at less than 50% relative humidity and 25° C regardless of line, chassis or recorder grounding. Better than 10^{10} ohms up to 80% relative humidity and 35° C. With externally driven guard, isolation improves by at least one order of magnitude up to 10^{13} ohms. Either input terminal can be floated 1100 volts off chassis ground.

DC COMMON MODE REJECTION: Better than 160 db with input short circuited, 140 db open circuited at 50% relative humidity, 120 db open circuited at 80% relative humidity.

AC COMMON MODE REJECTION: (below 100 KC) 100 volts RMS or 120 db greater than end scale, whichever is less, will affect reading less than 2% of end scale.

AC NORMAL MODE REJECTION: (60 cps and above) AC voltages 60 db above end scale will affect reading less than 2% of end scale. Maximum voltage not to exceed 750V RMS.

ZERO STABILITY: Better than 0.15 uv/hr.; better than 0.3 uv/day, at constant ambient temperature.

ZERO CONTROL RANGE: ±5 uv minimum.

RECORDER OUTPUT: 0-1 volt, one side at chassis ground; linear to 0.5% of end scale. Source Impedance 5 K to 7.5 K.

OPERATING TEMPERATURE RANGE: Within specifications from 15° C to 35° C. Slightly derated outside these limits to 0° C and 50° C.

STORAGE TEMPERATURE RANGE: Model 845A, -40° C to +70° C; Model 845AB, -40° C to +60° C.

TEMPERATURE COEFFICIENT: Less than 0.1 uv/° C from 15° C to 35° C. Less than 0.2 uv/° C from 0° C to 50° C.

RELATIVE HUMIDITY RANGE: 0 to 80%.

VIBRATION: Meets 10 cps -55 cps tests of MIL-T-945A.

OVERLOAD CAPABILITY: Up to 1100 VDC may be applied on any range. Typical recovery time is 4 seconds.

INPUT POWER: Model 845A - 115/230 VAC ±10%, 50-440 cps; Model 845AB - rechargeable battery or 115/230 VAC ±10%, 50-440 cps (40 hours operation on full charge, batteries trickle-charged while instrument operates from power line).

SIZE: 7" high x 8-1/2" wide x 8" deep (two units mount side-by-side in 19" rack with addition of dual rack mounting kit; one unit mounts in 19" rack with addition of single rack mounting kit).

WEIGHT:		
	Model 845A	10 lbs, 4 oz
	Model 845AB	9 lbs

SECTION II

OPERATING INSTRUCTIONS

2-1. CONTROLS, TERMINALS, AND INDICATORS

2-2. Before attempting to use the 845A, the operator should read and understand the following discussion of controls, terminals, and indicators:

a. INPUT and COMMON binding posts (J1 and J2). These posts are provided for connecting the dc voltage to be measured.

b. GUARD binding post (J3). This post is ordinarily strapped to the COMMON post and serves as a shield. By connecting a separate source having the same potential as that applied to the COMMON post to the GUARD post, leakage currents will be shunted through this alternate path raising the effective leakage resistance from COMMON to ground by about ten times.

c. POWER switch (S102 and S201). In the Model 845A, the POWER switch applies ac line voltage to primary circuit of power transformer when turned from OFF to ON. In the Model 845AB, positions for OFF, BAT CHK, and three modes of operations (LINE OPR, BAT CHG - LINE OPR, and BAT OPR) are available. When set to LINE OPR, ac line power is applied to primary circuit of power transformer. When set to BAT CHG - LINE OPR, ac line power is applied to primary circuit of power transformer and batteries are charged at the same time. When set to BAT OPR, battery power is applied to the instrument; one side of the primary circuit of the power transformer is opened. When set to BAT CHK, battery power is applied to the instrument, one side of the primary circuit is opened, and the meter is connected in series with a resistor to measure the voltage of the batteries.

d. OPR - ZERO switch (S103). This switch shorts the null detector input when set to ZERO but open circuits the input binding posts to prevent damage to anything connected to them.

e. ZERO control (R117). This control is used to electrically zero the instrument.

f. RANGE switch (S101). This switch selects the proper input divider and amplifier feedback impedances for each voltage range.

g. Meter (M1). This meter indicates the voltage applied to the input posts. A 10-0-10 scale is provided for the X1 progressions from 1 uv to 1000 v and a 3-0-3 scale is provided for the X3 progressions from 3 uv to 300 v. A BATTERY OK region, -7 to -10, indicates the condition of the batteries when the POWER switch is set to BAT CHK.

h. Mechanical zero control. This screw adjustment sets meter to zero mechanically.

i. ISOLATED OUTPUT binding posts. (J4 and J5). These posts are provided for attaching a recorder to monitor meter excursions.

j. LEVEL control (R1). The LEVEL control varies the output level of the ISOLATED OUTPUT posts from 0 to 1 volt dc at end scale deflection.

2-3. PRELIMINARY OPERATION FOR MODEL 845A

a. Connect power plug to a 115 volt ac power outlet. If instrument has been wired for 230 volt operation, connect to 230 volts ac.

WARNING

The round pin on polarized three-prong plug connects instrument case to power system ground. Use a three-to-two pin adapter when connecting to a two-contact receptacle. For personnel safety, connect short green lead to a good earth ground.

b. Set RANGE switch to 10 MICROVOLTS and POWER switch to ON.

c. Set OPR - ZERO switch to ZERO and adjust ZERO control for zero meter deflection.

d. Adjust ZERO control for zero meter deflection in the 1 and 3 MICROVOLTS ranges if desired.

2-4. PRELIMINARY OPERATION FOR MODEL 845AB

a. For line operation, connect power plug to a 115 volt ac power outlet. If instrument has been wired for 230 volt operation, connect to 230 volts ac.

WARNING

The round pin on polarized three-prong plug connects instrument case to power system ground. Use a three-to-two pin adapter when connecting to a two-contact receptacle. For personnel safety, connect short green lead to a good earth ground.

b. For line operation, set RANGE switch to 10 MICROVOLTS and POWER switch to LINE OPR.

c. For battery operation, set POWER switch to BAT CHK. Meter needle should deflect to BATTERY OK region. If meter needle does not stay within BATTERY OK region for 10 seconds, charge batteries as outlined in paragraph 2-7. If batteries are charged, set RANGE switch to 10 MICROVOLTS and POWER switch to BAT OPR.

d. Set OPR - ZERO switch to ZERO and adjust ZERO control for zero meter deflection.
e. Adjust ZERO control for zero meter deflection in the 1 and 3 MICROVOLTS ranges if desired.

2-5. MECHANICAL ZEROING INSTRUCTIONS

2-6. From time to time, it may be necessary to adjust the mechanical zero control. This will normally be done at somewhat more frequent intervals than complete instrument calibration. Proceed as follows:

a. Set RANGE switch to 1000 volts and POWER switch to ON for the 845A or to LINE OPR for the 845AB.
b. Adjust mechanical zero adjustment screw for zero meter deflection.

NOTE

If the meter needle moves counterclockwise when the adjustment screw is turned clockwise, rotate adjustment screw 180°. This will increase the adjustment screw resolution.

c. Set RANGE switch to 10 MICROVOLTS and electrically zero instrument as in steps c through d of paragraph 2-3.
d. Set RANGE switch to 1000 VOLTS and adjust mechanical zero adjustment screw for zero meter deflection.

2-7. BATTERY CHARGING (845AB ONLY)

a. Connect power plug to ac power outlet.
b. Set POWER switch to BAT CHG - LINE OPR. After 16 hours, batteries will be fully charged and capable of operating the instrument for at least 40 hours. While the batteries are being charged, the instrument can be operated.

CAUTION

Since extensive overcharging will cause internal polarization and thus a decrease in battery voltage and life, it is recommended that the batteries be charged for less than 48 hours and never more than 1 week. When properly used, the batteries will give more than 200 charge-discharge cycles of operation.

2-8. VOLTAGE MEASUREMENTS

a. Perform preliminary operation as stated in paragraph 2-3 or 2-4.
b. Set RANGE switch for end scale voltage deflection desired. If approximate value of voltage to be measured is unknown, select 1000 VOLTS range initially.
c. Connect voltage to be measured between INPUT and COMMON posts. If one side is grounded, always connect it to COMMON post.
d. Set OPR - ZERO switch to OPR.
e. Read voltage from meter scale. Deflection to the right indicates that unknown dc voltage is of positive polarity.

2-9. USE AS A NULL DETECTOR

2-10. The 845A may be used to monitor small voltage differences in bridge circuits, potentiometers, and other measuring equipment. In most of these applications the circuit is adjusted for zero deflection or a "null" on the 845A. To use the instrument as a null detector, proceed as follows:

a. Perform preliminary operation as stated in paragraph 2-3 or 2-4.
b. Set RANGE switch to desired range.
c. Connect INPUT and COMMON posts between circuit points at which a null is desired. The COMMON post should be connected to the circuit point that has the lowest impedance to ground.
d. Set OPR - ZERO switch to OPR.
e. Set RANGE switch to successively more sensitive ranges and adjust circuit for zero meter deflection in each range.

2-11. ISOLATED OUTPUT

2-12. Isolated output binding posts and an output level control are provided on the 845A for monitoring the variations of a voltage level or the fluctuations around a null point. The instrument may also be used as a dc isolation amplifier with a voltage gain up to 120 db depending on the range switch and output level control settings.

2-13. ISOLATED ADJUSTABLE RECORDER OUTPUT

2-14. For end scale meter deflection, the isolated output provides 0 to 1 volt dc with an output impedance of 5 K to 7.5 K depending on the setting of the level control. Since the output is isolated from the input, floating measurements can be made without the use of a floating recorder. To use the adjustable recorder output, proceed as follows:

a. Connect recorder to ISOLATED OUTPUT binding posts.

NOTE

The lower ISOLATED OUTPUT post is connected to chassis ground. If a ground reference is undesirable, disconnect green wire between power supply circuit board and grounding pin on ac line plug. This allows the isolated output to be floated up to 100 volts dc away from ground.

b. Set up recorder to operate as desired.
c. Proceed as instructed for voltage measurements (paragraph 2-8) or for use as a null detector (paragraph 2-9) as desired.
d. Adjust ISOLATED OUTPUT LEVEL control for desired output.

2-15. HIGH CURRENT RECORDER OUTPUT

2-16. Although the isolated adjustable recorder output impedance of 5 K to 7.5 K is adequate for the majority of applications, it limits the current that can be drawn from the output. A fixed output of 1 volt (±2%) for full range input with a current up to 1 milliampere at a very low output impedance is available from the instrument. However, this output is referenced to the input common binding post. Thus, floating measurements are limited by the leakage resistance between the recorder used and ground. To use the high current recorder output, proceed as follows:

a. Connect recorder between orange (amplifier output) and brown (amplifier common) wires at top of rear circuit board.
b. Set up recorder to operate as desired.
c. Proceed as instructed for voltage measurements (paragraph 2-8) or for use as a null detector (paragraph 2-9) as desired.

2-17. NOTES ON USE OF 845A

2-18. SPURIOUS VOLTAGES AND CURRENTS

2-19. Voltage measurements at the microvolt level involve the persistant problems of thermoelectric (thermal, Seebeck, thermocouple, thermel) effects and chemoelectric (electrochemical, voltaic, galvanic) effects. These effects can be compensated for by temporarily disconnecting the voltage from the circuit under measurement and cancelling out the thermoelectric and

chemoelectric effects by adjusting the zero control with the instrument in the desired range. The measurements taken with the voltage reconnected will not contain the errors from these effects, provided that they have not changed between the time the instrument was zeroed and the time of measurement. However, an understanding of these effects can lead to reducing or eliminating them completely.

2-20. THERMOELECTRIC EFFECTS. When a circuit is composed of two different metals, a net electromotive force will result if the two junctions are maintained at different temperatures. Unwanted thermoelectric voltages can be reduced or eliminated by either using metals having low thermoelectric temperature coefficients or by keeping all junctions at the same temperature. Since copper wire is almost universally used in low level circuits, the input binding posts of the 845A are made of pure copper with a thin gold plate to prevent tarnish. For best results, all connections between the 845A and the external circuit should be made with pure copper wire such as magnet wire. Silver plated copper or solder coated copper wire also produce satisfactory results. Tinned copper is less satisfactory. With nickel and nickel based alloys (kovar, dumet, constantan, manganin, etc.), meaningful microvolts measurements are almost impossible. Excellent results can be obtained using ordinary TV twin lead (or even lamp cord if the insulation requirements are not too stringent). When shielding is required, a length of flat braid can be slipped over the cable.

2-21. CHEMOELECTRIC EFFECTS. A battery results from a chemical reaction when two substances are placed in a reactive medium. Thus, chemoelectric effects result on the surface of a great number of insulators with the aid of dirt, perspiration, moisture, etc. These effects are noticeable only in high impedance circuitry due to their high source impedance. To check for the presence of chemoelectric effects, breathe on each portion of the circuit while observing the meter. A large meter excursion that disappears as the moisture evaporates is a sign of trouble. The knowledge of how to cure chemoelectric effects results largely from experience and experimentation. However, the following guidelines can be used:

a. Avoid glass insulation and glass-to-metal seals.
b. Use dielectrics having especially high surface resistivity and low moisture absorption. Teflon and Kel-F are the best, followed by polyethylene, polypropylene, and polycarbonates.
c. Keep all surfaces scrupulously clean.
d. Avoid any metal parts having a chromate finish.
e. Do not attempt to wipe off rosin flux unless it can be completely removed. Flux spread around in a thin layer is much more troublesome.

2-22. HIGH SOURCE IMPEDANCE

2-23. Due to the very beneficial high input resistance and extreme sensitivity of the instrument, it is charge sensitive. Thus, a persons body potential, an electrostatic voltage, can cause charge redistribution at the input to the instrument and result in meter needle deflection as a hand approaches the input terminals. Careful shielding will eliminate this problem. Also, due to charges that may be deposited on the input binding post when the OPR - ZERO switch is set to ZERO, an appreciable transient will result when the switch is set to OPR if nothing is connected to the input posts. Turning the switch back and forth once more will short out this charge eliminating the problem With high source impedances, the response of the instrument is unavoidably slow due to the low pass filter used to suppress superimposed noise. However, the design of the low pass filter is such that common mode rejection is extremely high while the response time for the usually encountered low source impedances is very fast.

2-24. CURRENT OFFSET

2-25. Due primarily to the characteristics of the photocells, a minute current is generated which flows through the source resistance. The resulting voltage can cause noticeable measurement error when the source resistance exceeds 500K. If current offset occurs when the unknown has a high source resistance, paragraph 2-9 should be modified to read as follows:

a. Perform steps 2-10a. through d.
b. Remove primary power from the source being measured.
c. With the OPR - ZERO switch set to OPR, adjust the ZERO control for zero meter deflection.
d. Apply primary power to the source being measured.
e. Set the RANGE switch to successively more sensitive ranges and adjust the circuit for zero meter deflection in each range.

2-26. Current offset tends to be more noticeable when the instrument is first used after a period of storage. This is because the photocells tend to change characteristics with prolonged darkness. Consequently, after a storage or idleness period exceeding 3 days, allow the instrument to warmup for a minimum of 30 minutes before use.

2-27. OVERLOAD VOLTAGES

2-28. The instrument is designed to withstand up to 1100 volts dc or 1100 volts peak ac continuously applied between any two of the three input post or between cabinet ground and any of the three input posts, regardless of the setting of the RANGE or OPR - ZERO switch. However, repeated or continuous overloads above 200 volts in the ranges below 3 millivolts will result in dissipation in protective, low-pass-filter resistor R110. This will result in thermal voltages which may take several minutes to die away after the overload is removed.

2-29. GUARDING

2-30. The instrument has an inner chassis connected to the GUARD post on the front panel. Ordinarily, this GUARD post is strapped to the COMMON post. When connected in this way the inner chassis serves as a shield and also alters the leakage paths within the instrument. This greatly improves the leakage resistance to ground and the common mode rejection. However, since the inner chassis is available at the GUARD post, it may be driven at the same voltage as the COMMON post. This further increases the leakage resistance and common mode rejection by about ten times. The voltage used to drive the GUARD post should be obtained from a separate source or by means of a voltage divider connected directly across the source so that the keakage currents do not cause voltage drops across impedances in the circuit under measurement.

2-31. INCREASING INPUT RESISTANCE

2-32. In the 1 uv to 1 mv ranges, a 10 megohm resistor is connected directly across the input of the instrument. The input resistance may be increased on these ranges by disconnecting the 10 megohm resistor where it attaches to the RANGE switch. However, the input resistance is no longer definite. Typical input resistances are as follows:

Range	Input Resistance
1 uv	300 megohms
3 uv	1000 megohms
10 uv	3000 megohms
30 uv to 1 mv	10,000 megohms

2-33. BATTERY CHARGING

2-34. If the instrument is left in the battery operating mode for an extended period of time, the batteries will become discharged. If the batteries are discharged completely, the instrument will not operate properly even in the LINE OPR mode until the battery voltage can be brought up to 3/4 of full voltage. This will require about 15 minutes of charging. It should also be noted that the voltage characteristic of the nickel-cadmium batteries is very flat except near full charge and complete discharge. Therefore, when the batteries are checked, the meter needle deflection will not be proportional to the remaining amper-hour capacity of the batteries. Just after the batteries are charged, the meter needle will indicate near -8.4. However, most of the time the batteries are charged the meter needle will indicate near -8.0. A few hours before the batteries need a recharge, the meter needle will indicate just within the BATTERY OK region.

SECTION III

CALIBRATION

3-1. TEST EQUIPMENT

3-2. Figure 3-1 lists the recommended equipment and specifications required for calibration. If the recommended equipment is not available, other equipment which meets the required specifications may be used.

NOMENCLATURE	SPECIFICATIONS REQUIRED	RECOMMENDED INSTRUMENT
Power Supply	Output Voltage: 100 vdc Resolution: 100 mv	FLUKE Model 407D Power Supply
DC Voltmeter	Range: 100 volts Accuracy: 0.1%	Any FLUKE Differential Voltmeter
Frequency Counter	Must be able to measure 84 hertz with an accuracy of 1%	Hewlett-Packard Model 521 Electronic Counter

Figure 3-1. CALIBRATION EQUIPMENT

3-3. METER CALIBRATION

3-4. The meter circuit of the 845A should only need to be calibrated every few years. Proceed as follows:

a. Mechanically zero instrument as stated in paragraph 2-5.
b. Set RANGE switch to 100 VOLTS.
c. Connect power supply and differential voltmeter between INPUT and COMMON posts of 845A.
d. Adjust power supply for an output of 100 volts (±0.2%) as measured with differential voltmeter.
e. Adjust R151 for end scale deflection of 845A meter needle.

3-5. CHOPPER FREQUENCY ADJUSTMENT

3-6. The frequency of the electronic chopper should be adjusted if a part in the circuit is replaced or if line operation causes the meter to beat due to the relationship of the chopper frequency with the line power frequency. Proceed as follows:

a. Set POWER switch to ON with 845A or to LINE OPR with 845AB.
b. Connect counter between collector of Q201 and chassis ground.
c. Adjust R206 for a frequency of 84 hertz as indicated on counter.

SECTION IV

DISASSEMBLY

This section contains a complete disassembly procedure which can be performed in a few minutes. Proceed as follows:

a. Take off top-back cover by removing four screws that fasten it to side castings. This allows access to the parts on the power supply board (parts with 200 series reference designations).

b. Take off bottom cover by removing two screws that fasten it to side castings. This allows access to capacitors C1 and C2 on the front panel.

c. Take off large side cover on both sides of instrument by removing two screws that fasten each of them to side castings.

d. Take off top cover of guard chassis by removing four screws, two on top of guard and two on back. This allows access to the dc amplifier (Q107 to Q112) and the last two stages of the chopper amplifier (Q104 to Q106). The instrument will still operate properly with top of guard chassis removed. When instrument is turned on, a red neon glow from the two Lucite rods on the amplifier board is an indication that the chopper drive circuit is working.

e. Take off bottom-back cover of guard chassis by removing two screws on bottom. This allows access to the input divider (R101 to R110), the +15 and -15 volt supply filter capacitors (C117 and C118), and the recorder output modulator (Q113 and Q114). The instrument will still operate but will have an offset especially with high source impedances.

f. Remove screw that fastens right side casting to front panel at top of instrument.

g. Take off right small side cover by removing two screws.

h. Loosen four screws that were covered by right small side cover two turns only.

CAUTION

Avoid touching polyethelene grommets. Grease from the hands can cause excessive electrical leakage.

i. Remove top and bottom screws that fasten right side casting to power supply board bracket.

j. Loosen top and bottom screws that fasten left side casting to power supply board bracket two turns.

k. Take off power plug bracket at rear of instrument by removing two screws that fasten it to side castings.

l. Pull rear of right side casting out far enough to swing power supply board bracket out back of instrument. This allows access to the entire component side of the amplifier board.

m. Take off input shield at end of Lucite rods by removing two screws. This allows access to the first three amplifier stages (Q101 to Q103) and the chopper drive photocells (V101 and V102).

n. If it is necessary to get at the land side of amplifier board, proceed as follows:

(1) Set RANGE switch to 1 MICROVOLTS and loosen set screw pointed toward bottom of instrument.

(2) Set RANGE switch to 1000 VOLTS, loosen other set screw now pointed down, and take off knob.

(3) Loosen set screw on ZERO control shaft coupler where it connects to potentiometer.

(4) Using a 1/2" socket wrench, remove nut that holds range switch to guard chassis.

(5) Remove four screws that hold amplifier board to guard chassis.

(6) Slide amplifier board toward rear of instrument. This allows access to the land side.

WARRANTY

The JOHN FLUKE MFG. CO., INC. warrants each instrument manufactured by them to be free from defects in material and workmanship. Their obligation under this Warranty is limited to servicing or adjusting an instrument returned to the factory for that purpose, and to making good at the factory any part or parts thereof; except tubes, fuses, choppers and batteries, which shall, within one year after making delivery to the original purchaser, be returned by the original purchaser with transportation charges prepaid, and which upon their examination shall disclose to their satisfaction to have been thus defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at a nominal cost. In this case, an estimate will be submitted before work is started, if requested.

If any fault develops, the following steps should be taken.

1. Notify the John Fluke Mfg. Co., Inc., giving full details of the difficulty, and include the Model number, type number, and serial number. On receipt of this information, service data or shipping instructions will be forwarded to you.

2. On receipt of the shipping instructions, forward the instrument prepaid, and repairs will be made at the factory. If requested, an estimate of the charges will be made before the work begins, provided the instrument is not covered by the Warranty.

SHIPPING

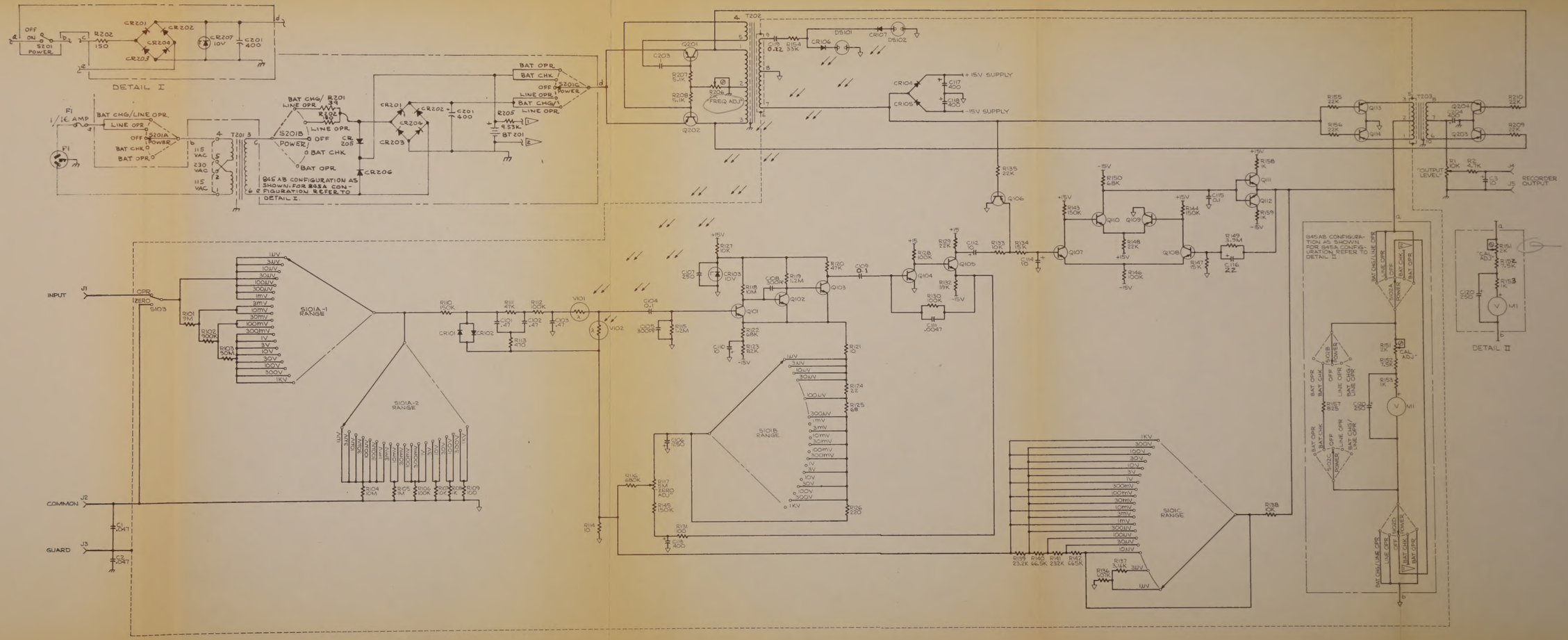
All shipments of John Fluke Mfg. Co., Inc. instruments should be made via Railway Express prepaid. The instrument should be shipped in the original packing carton; or if it is not available, use any suitable container that is rigid. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be thoroughly inspected immediately upon receipt. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to John Fluke Mfg. Co., Inc. Upon receipt of this report you will be advised of the disposition of the equipment for repair or replacement. Include the model number, type number, and serial number when referring to this instrument for any reason.

The John Fluke Mfg. Co., Inc. will be happy to answer all application questions which will enhance your use of this instrument. Please address your requests to:

JOHN FLUKE MFG. CO., INC., P. O. BOX 7428, SEATTLE 33, WASHINGTON



REFERENCE DESIGNATIONS:
BT 201
C1-3, 101-120, 201-203, 205, 206
CR101-107, 201-207
DS101-102
J1-5
M1
P1
Q101-114, 201-204
R1-3, 101-159, 201, 202, 205-210
S101-103, 201
T201-203
V101-102

NOTES:

- ALL FLAGNOTES WITH THE SAME NUMBER ARE CONNECTED.
- INDICATES NULL DETECTOR COMMON.
- INDICATES CHASSIS GROUND.
- INDICATES INTERNAL ADJUSTMENT.

UNLESS OTHERWISE INDICATED RESISTANCE IS IN OHMS AND CAPACITANCE IS IN MICROFARADS.

CHANGES:
① FOR SER. NOS. 123 THRU 370: PREVIOUS TITLE WAS: "NULL DETECTOR/ MICROVOLTMETER."

FUNCTIONAL SCHEMATIC b

HIGH IMPEDANCE VOLTMETER / NULL DETECTOR

MODEL 845A & 845AB

MODEL 845A & 845AB SER. NO. 123 & ON

FLUKE JOHN FLUKE MFG. CO., INC.
P.O. Box 7428 Seattle, Washington 98133